Unmasking Fault Tolerance: Masking vs. Non-masking Fault-tolerant Systems

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AVACS

- Automatic Verification and Analysis of Complex Systems
- transregional: 3 Universities, $3 * 4$ years, now in year 6
- Oldenburg, Saarbrücken, Freiburg
- hybrid systems
- fault model driven stochastic model checking
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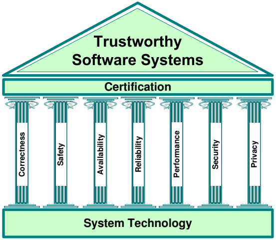

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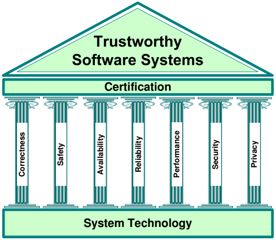

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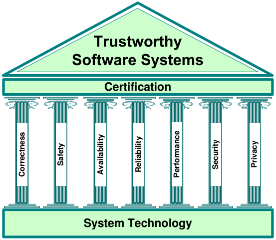

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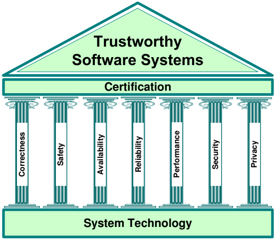

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    - distributed systems
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- focusing on distributed systems
- fault tolerance: reliability, availability, maintainability, ...
- it is a quality of service

	safe	¬ **safe**
live	masking	nonmasking
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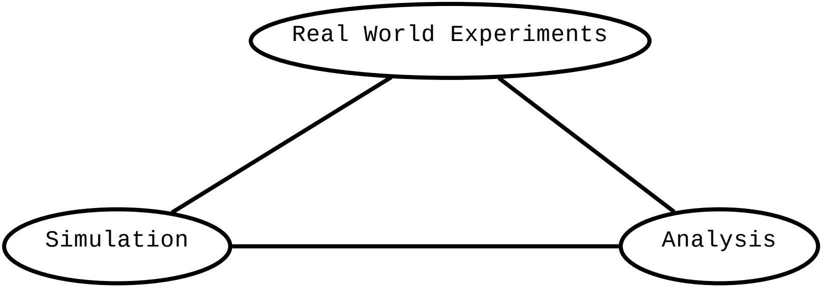

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- formal analysis ⇒ state space explosion
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- based on Markov models (DTMC, CTMC, DTMDP, CTMDP):
- probabilistic model checker PRISM:
  - generates model (3 proc ⇒ 6561 states, 5 proc ⇒∼ 7 billion states)
  - checks model against predicates
  - gives quantitative answers (e.g., 0.0756312876123 is the steady state probability of state x)
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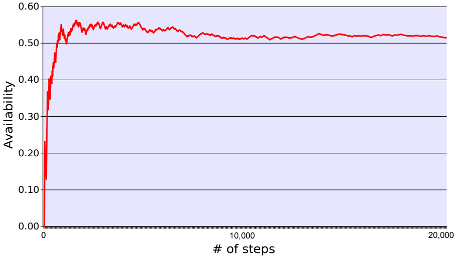

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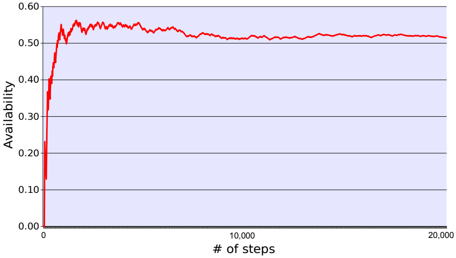

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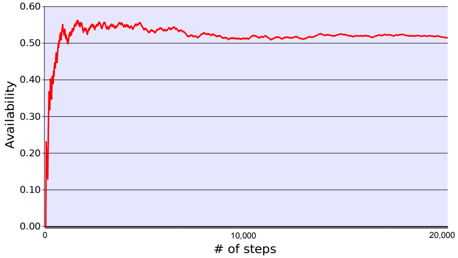

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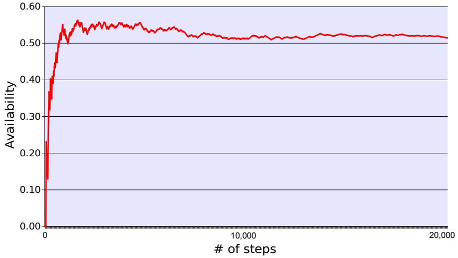

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- applicable scenarios: wireless sensor networks (WSN)
  - too expensive ($\sim$200 AUD/mote, $\sim$100 motes for a realistic network)
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- simulation and analysis deliver similar results (two papers)

- derivation of fault tolerance measures challenging
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Instantaneous Window Availability

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- to be extended: IW reliability, maintainability,...
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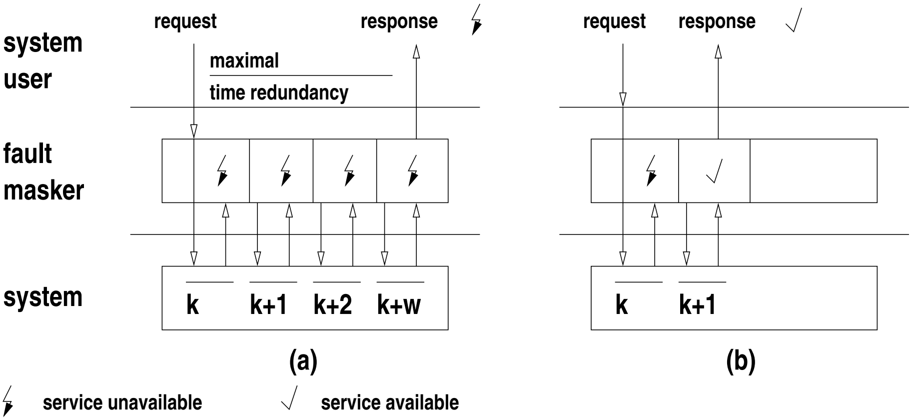

system
user
fault
masker
system
request
response
maximal
time redundancy
k
k+1
k+2
k+w
(a)
request
response
k
k+1
(b)
service unavailable
service available

Work In Progress

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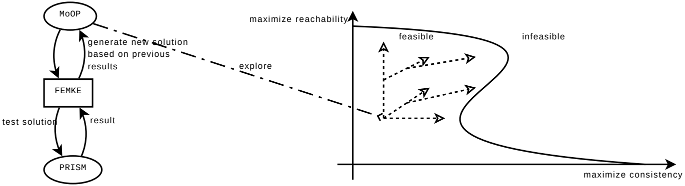

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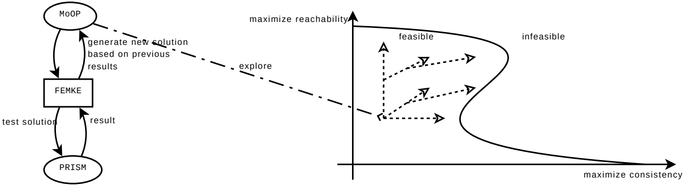

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  - state space explosion in analysis
  - inaccurate results in simulation
  - high costs in real world
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  - to model
  - to analyze
- simulation alleviates this burden somewhat at the cost of accuracy/proof
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Bonus: fun with weakening the masking property 1/3

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- during stabilization/repair phase, user is exposed to faults
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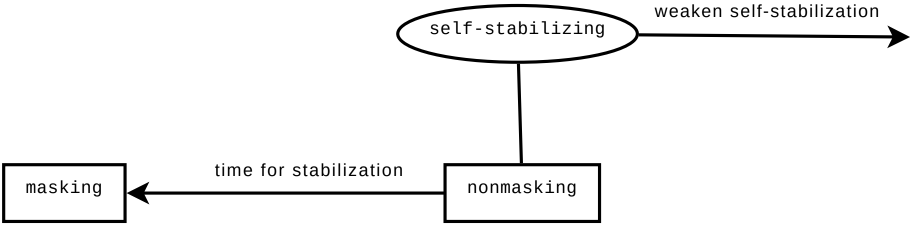

Bonus: fun with weakening the masking property 3/3

- convergence: $\exists t_k : x(t_k) \models P$
- closure: $\forall t \geq t_k : x(t_k) \models P \Rightarrow x(t) \models P$
- attack at convergence: slow or probabilistic
- attack at closure: $\exists t_0 \forall t \geq t_0 : x(t) \models P$

Bonus: fun with weakening the masking property 3/3

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- closure: $\forall t \geq t_k : x(t_k) \models P \Rightarrow x(t) \models P$
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Attack Convergence

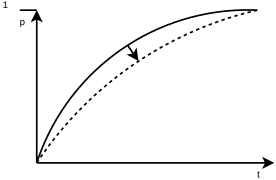


Figure: slower stabilization

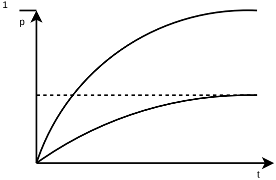
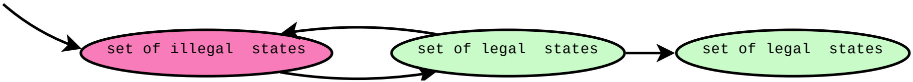


Figure: probabilistic stabilization

Attack Closure



Thank your for your attention.

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Questions?

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